Non-Chemical Control Of Algae

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What do you Normally do with Barley?

BEER!
Ancient Egypt's gift to mankind!

What else?

Use AEROBICALLY rotting straw to improve color, clarity and suspended solids.

Barley Basics

Effects were discovered in 1980's
University of Bristol, Department of Agriculture Science
Professor J. R. Newman

- Controlled algae in stock ponds
- Laboratory studies begun
- Examined both algal and fungi forms
- Observed Inhibition – Re-growth – Inhibition

NOTED - Significant chemicals released

Barley Basics

- Barley decomposes slowly in the water
- Decomposition chemicals are released (H_2O_2, polyphenolics)
- Process occurs at a microbial level
- Algae cell walls lysis
- Temperature is one dependent factor
- Algae growth continues
- Color (tannin) is not considered to be a factor
- Process NOT fully studied or understood

Barley Basics

- About Hydrogen Peroxide - H_2O_2
- Found to be a product of decomposition
- Does not appear to be effective alone
- About Polyphenols - Tannins
- Found to be a product of decomposition
- Tannins are hydrolyzed by weak acids or weak bases to produce carbohydrate and phenolic acids

Barley Basics

Decomposition starts slowly

Water may turn light brown initially - tannins

Continues for four to six weeks

If you see straw, decomposition is occurring

Varies by algae

- Unicellular algae affected first
- Long stringing algae take longer
- Sludge mats unaffected
- Pond scum unaffected
- Duckweed unaffected

Applying Barley

Floating booms "barley burrito"

- Allow for wind and wave mixing
- Away from structures (aerators)

Effectiveness is proportional to quantity

- Therefore, replace regularly

Surface area not volume is main factor

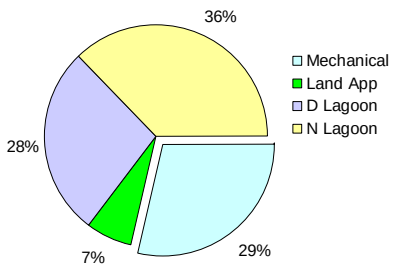
- 175 to 350 pounds per acre

UDWQ Barley Study

After reading this research, the Division of Water Quality, began to investigate the possibility of using Barley on a hypertrophic system – wastewater lagoon

Why was UDWQ interested?

Utah's Municipal Wastewater Treatment Plants by Type



Wastewater Algaes

Most of the breakdown of organic waste in a wastewater lagoon system is done by aerobic decomposition

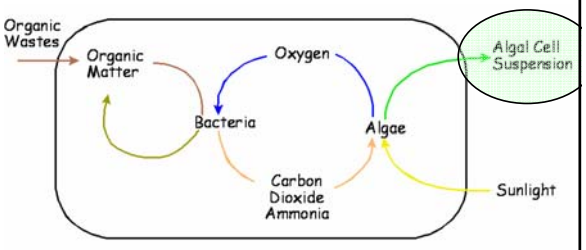
How is oxygen supplied?

Aeration

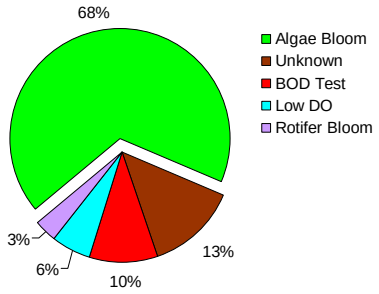
Wind action

Algae – photosynthesis

Cycle of Controlled Photosynthesis in Organic Waste



Causes of high effluent BOD and TSS

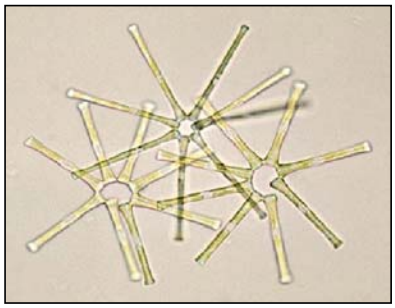


Decomposing Barley Straw

Brown - Diatoms (spring)

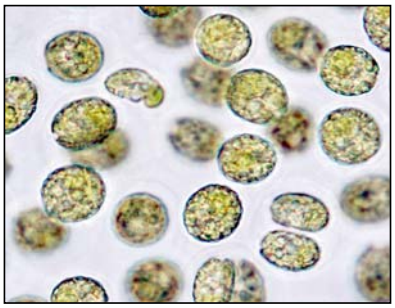
Decomposing Barley Straw

Brown - Diatoms (spring)



Decomposing Barley Straw

Green - *Chlorella* (early summer)

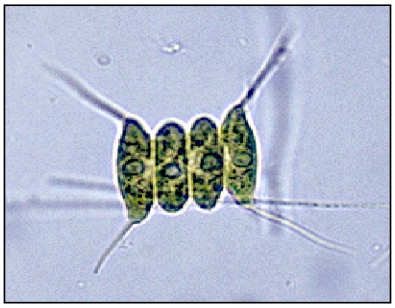


Decomposing Barley Straw

Green - *Euglena* (early summer)

Decomposing Barley Straw

Green - *Scenesdesmus* (late summer)



Decomposing Barley Straw

Green - *Ankistrodemus* (late summer)

Decomposing Barley Straw

Blue-Green - *Nostoc* (fall)

Decomposing Barley Straw

Blue-Green - *Microcystis* (fall)

Decomposing Barley Straw

DWQ Barley Study

In 2004 DWQ partnered with Mt. Green SID to evaluated the effect of barley straw for algae (total suspended solids) control

Applied barley

Conducted weekly TSS sampling

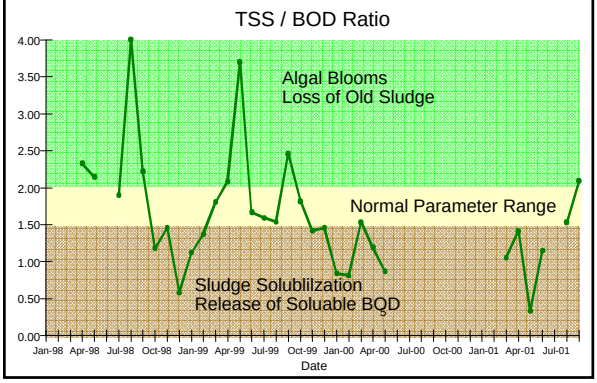
Thanks to Central Davis SD for providing the testing

Decomposing Barley Straw

TSS:BOD Ratio

TSS:BOD Ratio	Possible Causes
<1	old sludge solubilization and release of soluble BOD_5 nitrification in the test bottle
1	poor treatment or short circuiting with loss of untreated wastewater to the effluent
1.5	normal for most lagoon systems
>2.0	**algal overgrowth** loss of old sludge particles

Mt. Green



Mt. Green – Case Study

About 40 miles Northeast of Salt Lake

Population 1,200 (2004)

Rapid growth

Large receiving stream – Weber River

Annual suspended solids problem (surprise!)

NOV issued (fine collected)

Mt. Green – Case Study

Three - cell aerated lagoon

Daily flow - 132,000 gpd

Influent - BOD_5 = 150 - 235mg/L

Influent - TSS = 185 - 280 mg/L

Permit limits - BOD_5 45 mg/L, TSS 45 mg/L

Mt. Green – Case Study

Application method

Application - 1 oz / yd^2 (303 lbs / acre) - 3 bails!

Flotation - 3 gallon jugs, 6 feet apart

Sealant - silicon to seal caps

Configuration - sausage boom

Location - diagonally, upwind, in mixing pattern

Anchor - double strands of poly rope tied to posts

Mt. Green – Case Study

DWQ personnel conned into doing this!

5/19/04

Beta version

Mt. Green – Case Study

Decomposing Barley Straw

Mt. Green – Case Study

Mt. Green – Case Study

Watch it rot

5/26/04

Decomposing Barley Straw

Mt. Green – Case Study

Watch it rot

6/23/04

Decomposing Barley Straw

Mt. Green – Case Study

rebuild

6/30/04

Zip-tie version

Decomposing Barley Straw

Mt. Green – Case Study

Costs

Three forty-pound bales of barley straw @ $1

One 100 ft roll of snow fence @ $30

Two rolls 350 lb test polyethylene rope @ $10

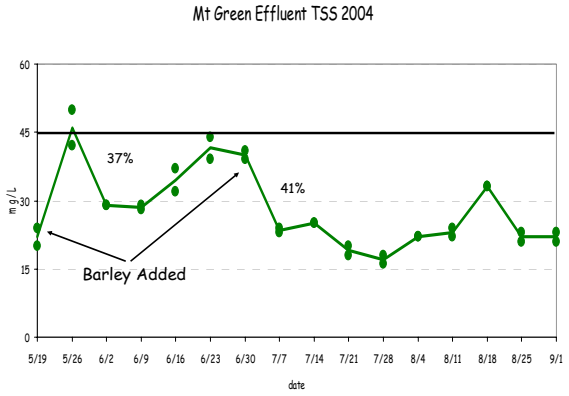
Two fence post @ $1.89

Three Government demonstrators @ $ 0.01 (over paid)

Two and a half hours on a sunny day

Total – approximately $45

Decomposing Barley Straw



Mt. Green – Case Study

No violations in 2004 - 2007

Average TSS 1999 – 2003 - 34 mg/L

Average TSS 2004 – 2007 - 24 mg/L

29.4 % decrease in TSS values

Appears to show a dose response relationship

DWQ Barley Study

Based upon the results from Mt. Green, DWQ partnered with Utah Rural Water to conduct more studies

Ash Creek SID

Eureka City

Salem City

Southern Utah Fuels Company

Pacific States Cast Iron

Ash Creek – Case Study

A Land application treatment

About 15 miles northeast of St. George

Population 9,800 (2005)

Rapid growth

Land application treatment

Looking to reduce chlorine costs

Ash Creek – Case Study

Ash Creek – Case Study

Ash Creek – Case Study

Decomposing Barley Straw

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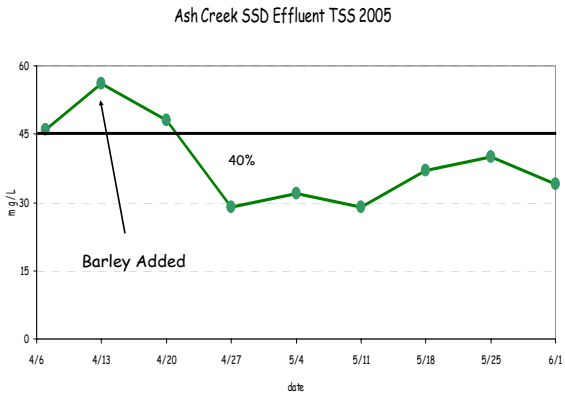
Ash Creek – Case Study

Decomposing Barley Straw



Ash Creek – Case Study

40 % decrease in TSS values

Appears to show a dose response relationship

Decomposing Barley Straw

Salem – Case Study

About 50 miles South of Salt Lake

Population 6,500

Rapid growth

Small receiving stream – Beer Creek

Annual suspended solids problem (surprise!)

NOV issued (fine collected)

Decomposing Barley Straw

Salem – Case Study

Three - cell aerated lagoon

Daily flow - 785,000 gpd

Influent - BOD_5 = 74 – 287 mg/L

Influent - TSS = 94 - 444 mg/L

Permit limits - BOD_5 45 mg/L, TSS 45 mg/L

Salem – Case Study

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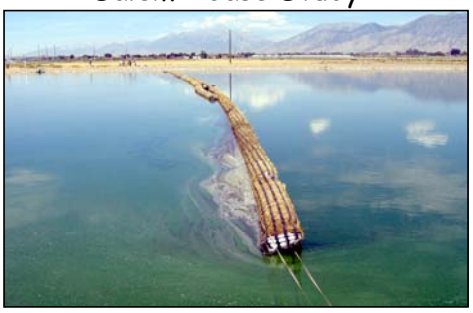
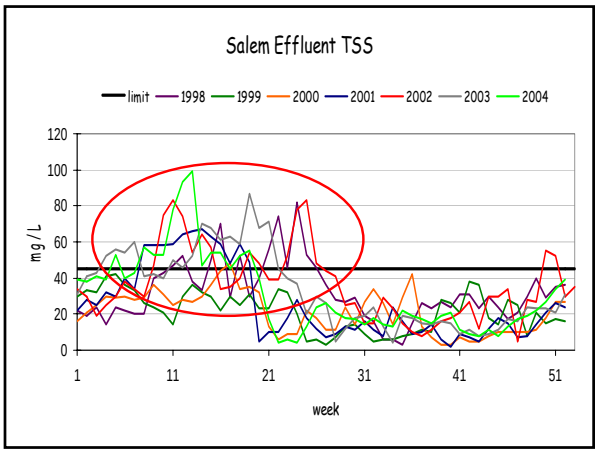
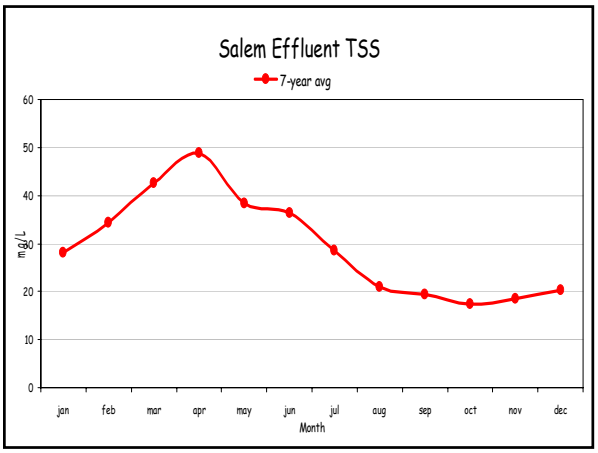
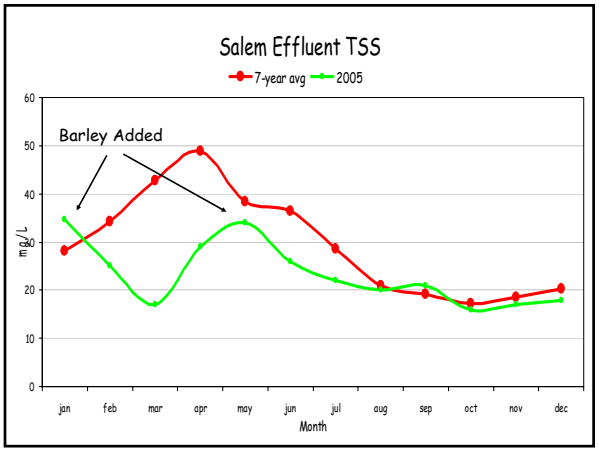
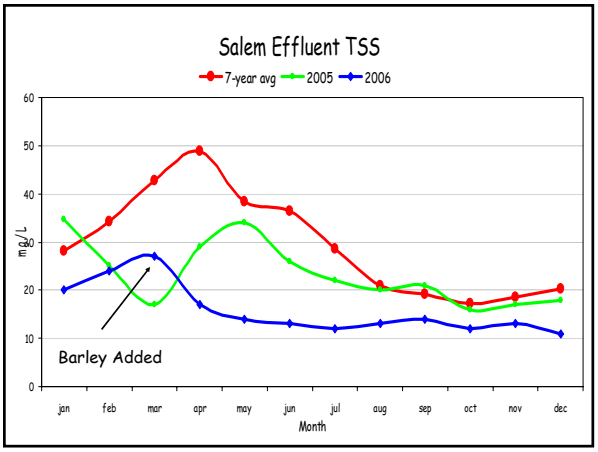
Salem – Case Study











Salem – Case Study

No violations in 2005 - 2007

Average TSS 1998 – 2004 - 29 mg/L

Average TSS 2005 – 23 mg/L

Average TSS 2006 – 16 mg/L

46.2 % decrease in TSS values

Appears to show better response in second year

SUFO – Case Study

About 250 miles South of Salt Lake

Large Coal Mine

Runoff sediment pond

Small receiving stream – Quichapah Creek

Annual suspended solids problem

UNCLEAR IF IT WORK!

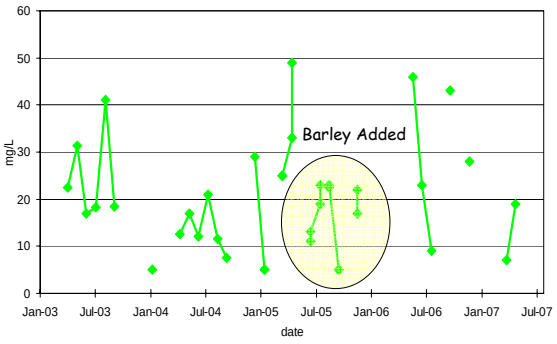
SUFCO

Decomposing Barley Straw

SUFCO

Decomposing Barley Straw

SUFCO TSS



SUFO – Case Study

No BOD samples

Unsure what TSS is composed of

Average TSS without Barley – 23 mg/L

Average TSS with Barley boom – 16 mg/L

Decomposing Barley Straw

PSCIPCO – Case Study

About 50 miles South of Salt Lake

Large Steel Mill

Cooling water pond

Large receiving stream – Utah Lake

Occasional suspended solids problem

UNCLEAR IF IT WORK!

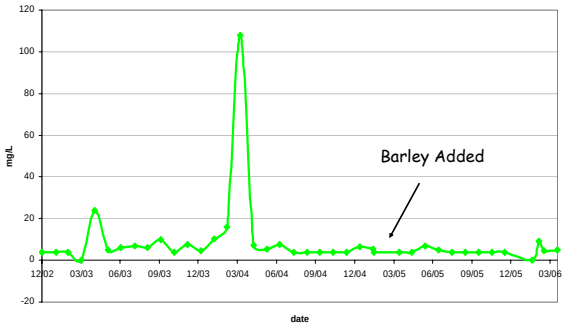
Decomposing Barley Straw

PSCIPCO

Decomposing Barley Straw

PSCIPCO

PSCIPCO TSS



SUFO – Case Study

No BOD samples

TSS appears to be seasonal

No 2005 spike

Eureka – Case Study

About 50 miles Southwest of Salt Lake

Population 700

Losing population

Small receiving stream – Dry Wash

Annual suspended solids problem (surprise!)

DID NOT WORK!

Eureka

Eureka

Eureka

Study Conclusions

Algae blooms appear to be effected by the straw

Has reduced the number of permit violations

Reduced the TSS discharged

Reduced the chlorine demand

Simple

Cheap!

Cynobacteria does not seem effected by barley

Questions ?